

Western Electric Co., Incorporated,
Equipment Engineering Branch, Hawthorne.

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Issue 3 BT 431628
Appendix 1
May 16, 1925.

This M. of O. was written from Issue 42 of T-431628.

METHOD OF OPERATION

Line Circuit - Trip Circuit - Start Circuit - Line Finder Circuit District
Selector Circuit & Time Alarm Circuit - Arranged for Two Party Message Register
Lines.- Panel Machine Switching System.

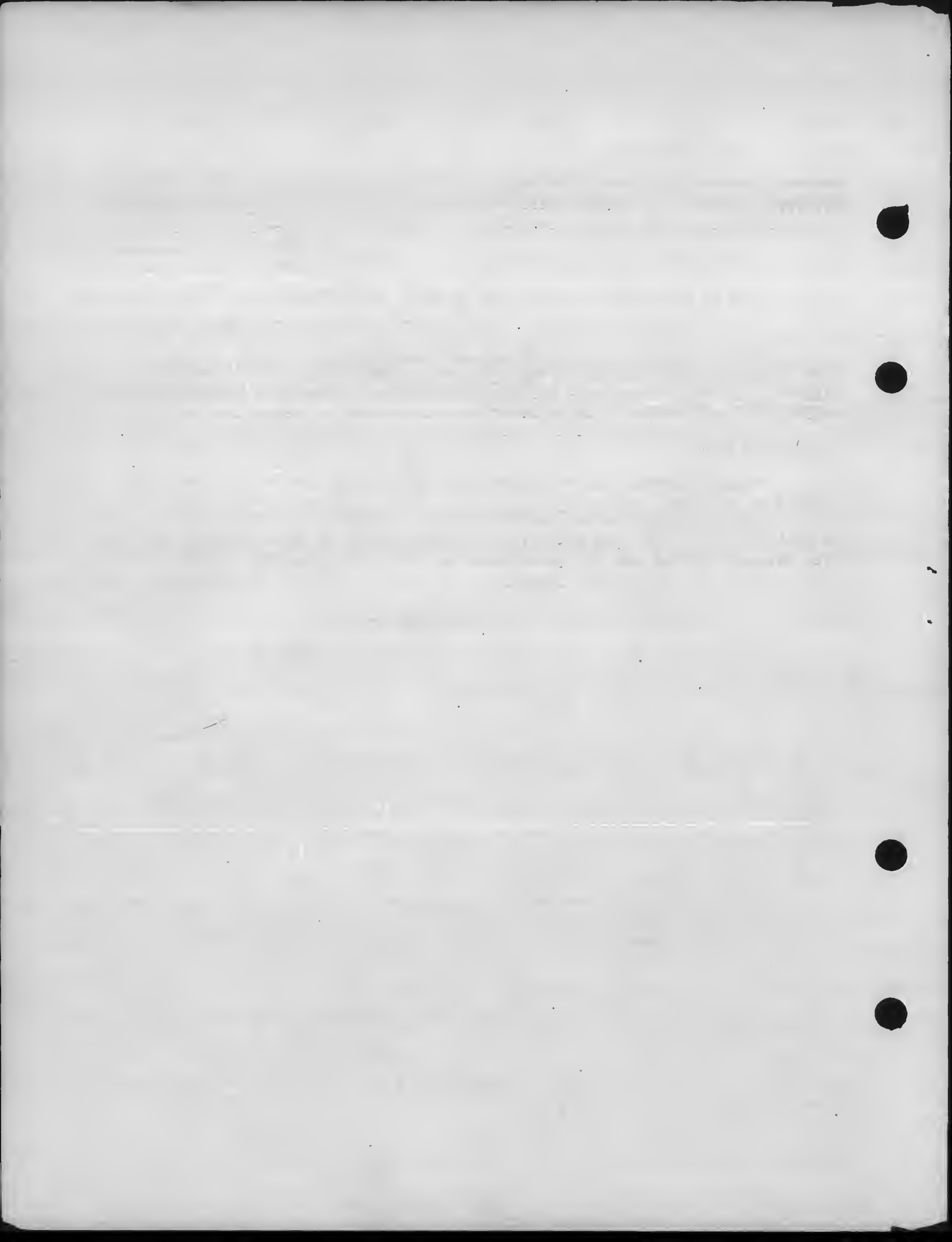
Change sentence commencing on line 13 of paragraph 34 to 2 sentences
reading as follows:

As the switch leaves position 9, the dialing circuit is opened at cam P.
In position 9 3/4 the ring lead from the line finder is closed through cam Q to
(PT) selector switch and in position 10 the tip lead is closed through cam P.

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5/19/25
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Western Electric Company, Incorporated,
Equipment Engineering Branch, Hawthorne.

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October 18, 1923 (*)
Replacing all previous issues.

This M. of O. prepared from Issue 37 of T-431628.

METHOD OF OPERATION

Line Circuit - Trip Circuit - Start Circuit - Line Finder Circuit District Selector Circuit & Time Alarm Circuit.- Arranged for Two party message register lines Panel Machine Switching System.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

- 1.1 This circuit is arranged to find the calling subscriber's line and connect it with the various switching apparatus necessary to complete a call.

2. WORKING LIMITS

- 2.1 This circuit has a maximum external circuit loop range of 5010 ohms. It is also used with subscriber's loops of 900 ohms resistance maximum and minimum leak of 10,000 ohms.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are:

- 3.1 To find the proper line and start the sender selector hunting for an idle sender.
- 3.2 To establish talking connections.
- 3.3 To supply talking battery to the calling station.
- 3.4 To test the line to determine which party is calling.
- 3.5 To operate the proper message register on a charge call.
- 3.6 To connect a busy tone to the calling station, if required.
- 3.7 To disconnect battery and ground from the subscriber's line on an incoming call.
- 3.8 To provide a time interval of 35 seconds before a signal is given on calls where the line finder fails to find the calling line.

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- 3.9 To advance to the next normal terminal when the key is operated.
- 3.10 To route the calls to the respective line finder selector.
- 3.11 To distribute calls uniformly to the start circuits.

4. CONNECTING CIRCUITS

This circuit will function with:

- 4.1 Any standard subscriber's sender or incoming circuit.

DESCRIPTION OF OPERATION - LINE AND TRIP CIRCUITS

5. ORIGINATING A CALL

The operation of a call originating in the first ten lines of a group is as follows:- When the receiver at the calling station is removed from the switchhook, the (L) relay in the line circuit operates, through the 200 ohm resistance, winding of the (L) relay, contact of the (CO) relay, ring side of the line through the subscriber's loop, back over the tip side to ground on the armature of the (CO) relay. The line relay (L) operated, connects battery to the H terminal of the line and operates the (BA) relay through its inner winding. The (BA) relay operated, operates the (TR) relay from ground on the armature of the (BA) relay, break contact of the (K) relay, 700 ohm winding of the (TR) relay to battery over the (TR) lead. The (TR) relay operated, operates the two trip magnets, (b) opens the locking series circuit through the (TR) relays in the other bank groups and (c) locks through its 600 ohm winding to battery on terminal 1 and brush of the G group distributor selector, in series with the (STA) relay in the start circuit.

6. STARTING A LINE FINDER

When the (STA) relay in the Start circuit operates, it starts a line finder hunting for the calling line. Each TRIP magnet operates its trip rod, thus tripping the corresponding group brushes of the associated selectors on its respective side of the frame as the line finder selector starts upward. Ground on the K lead operates the (K) relay which, (a) locks to ground on the armature of the (BA) relay under control of the (O) relay, (b) opens the circuit through the 700 ohm winding of the (TR) relay, thus preventing another line finder selector from being started by this call (c) closes a circuit from the 1500 ohm winding of the (O) relay, but the (O) relay does not operate

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at this time on account of insufficient current through the winding. As the line finder selector moves upward and at the end of the tripping zone, ground on the K commutator brush and segment, short circuits the 600 ohms winding of the (TR) relay. The (TR) relay released, closes the locking series circuit through the (TR) relays in the other groups and opens the circuit through the two trip magnets, which release.

7. RELEASING THE TRIP CIRCUIT

When the selector brushes make contact with the terminals associated with the calling line, battery on the H terminal operates the (O) relay. The (O) relay operated, opens the locking circuit of the (K) relay but the (K) relay is very slow in releasing and holds the (O) relay operated through the 1500 ohm winding in order to permit the (BA) relay to release before the (O) relay, otherwise another line finder may be started by this call. When the line has been found the district functions and connects battery to lead S, operating the (CO) relay. The (CO) relay operated, releases the line (L) relay which in turn releases the (BA) relay thus opening the circuit, releasing the (O) relay. Another call may now start within this same group of ten lines if the starting circuit is ready for the call. The operation for a call originating in the last ten lines of a group of twenty, will be similar to that already described for the first ten lines except that the (BA-1), (K-1), (O-1), and (TR-1) relays are involved instead of the (BA), (O), (TR) and (K) relays.

8. SIMULTANEOUS CALLS

If there are simultaneous calls in both the first and last ten lines of a group of twenty- lines, the relays of both sub-groups will operate as already described, starting two line finder selectors in different sub-groups at the same time. In this case, the inner windings of the (O) and (O-1) relays are connected together through the make contacts of the (BA) and (BA-1) relays. The (O) and (O-1) relays will therefore operate in parallel when the H brush of either or both line finder selectors make contact with the H terminals of the calling line.

9. MESSAGE REGISTER

The two party message register district which is associated with this circuit is arranged to test the subscribers line to determine which subscriber is calling. When this test has been made and the district advances to its message registering position, the (CO) relay is either held operated or released depending upon which party is calling and battery is connected to lead H, thus operating the (MR-1) or (MR-2) message register.

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10. TERMINATING CALLS

When the final selector connects to the tip, ring and sleeve terminals of an idle line at the final multiple, battery through a resistance in the final circuit is connected over the S lead to ground through both windings of the (CO) relay (on individual lines or the last line of a group of consecutive lines) or through the 100 ohm winding of the (CO) relay (on intermediate lines of a group of consecutive lines). The (CO) relay operated, disconnects the L relay battery bridge from across the tip and ring of the line. When the final selector returns to normal, the circuit through the winding of the (CO) relay is opened, releasing the relay and restoring the circuit to normal.

OPERATION START CIRCUIT

11. ORIGINATING CALL

When the receiver at the calling station is removed from the switchhook, various relays in the line and trip circuits operate, operating the (STA) relay from ground over lead I, terminal 1 and brush of the (G) group distributor selector, break contacts of the (C), (CA) and (SB) relays to battery through the 18-BH resistance in parallel with the winding of the (ST-A) relay. The (ST-A) relay operated, (a) operates (STP-G) magnet, which remains operated until the (ST-A) relay releases, (b) short circuits the 500 ohm winding of the (CA) relay, preventing it from operating and starting a line finder in sub-group (B), while a call is going through, (c) connects ground to lead (K) and (d) closes a circuit over lead (ST) thus starting a line finder hunting for the calling line.

12. STARTING LINE FINDER

As the line finder starts upward a circuit is closed over lead (Y) operating the (GA) relay. The (GA) relay operated, removes ground from lead (ST), locks to ground on the armature of the (ST-A) relay and closes a circuit operating the (STP-A) magnet. This circuit is traced from ground on the make contact of the (ST-A) relay, make contact of the (GA) relay, terminal and brush of the (A-3) arc of the (A) selector, to battery through the winding of the (STP-A) magnet. The (STP-A) magnet remains operated until the release of the (ST-A) relay. Ground is connected to lead (CH) operating the (CA) or (CB) relay when all line finder selectors in a group are off normal. As the line finder continues upward ground is

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momentarily connected to lead (K), thus releasing a relay in the trip circuit but holding the (STA) relay operated. When the group is disconnected from lead (K), the (STA) relay releases and (a) opens the locking circuit through the (GA) relay, which release, (b) opens the circuit over lead (K), (c) opens the circuit through the (STP-G) magnet, which releases and steps the brushes of the (G) group distributor selector to the next terminals, (d) opens the circuit through the (STP-A) magnet, which releases and steps the brushes of the A group distributor selector to the next terminals (a) removes the short circuit from the 500 ohm winding of the (CA) relay, which does not operate unless all selectors in the group are busy.

13. EMERGENCY RELEASE OF START CIRCUIT

If either the (STA) or the (STB) relay remains operated, due to the failure of the (TR) or (TR-1) relay in the trip circuit to be shunted out and released, the (KF) relay operates as soon as the interrupter contacts I, III and V close, and locks under control of the (STA) or (STB) relay. If it remains locked for two seconds, interrupter contacts II and IV close ground to either the (TR) or (TR-1) relay in the trip circuit, (depending upon whether the call is through the "A" or "B" sub-group), releasing the (TR) or (TR-1) relay. When ground is removed by the opening of the interrupter contacts II or IV, the (STA) or the (STB) relay releases, releasing the (KF) relay and restoring the circuit to normal.

14. START CIRCUIT ALARM

The closure of the interrupter contact VI, which occurs at the same time contacts II and IV are closed, while the (KF) relay is operated, operates the (KA) relay. The (KA) relay operated, (a) locks under control of a key at the trouble desk, (b) lights a lamp at the trouble desk, individual to the line finder frame and operates an alarm. The operation of the key releases the (KA) relay, extinguishing the lamp and silencing the alarm. The operation for a call originating in the last 10 lines of a group of 20 will be similar to that already described for the first 10 lines, except that the (ST-B) and (GB) relays are involved instead of the (ST-A) and (GA) relays.

15. ALL SELECTIONS IN ONE SUB-GROUP BUSY

If all the selectors in sub-group "A", for example, are busy, the (CA) relay operates over a circuit from ground over lead (CH), 500 ohm winding of the (CA) relay, to battery through the 600 ohm resistance (C). The (CA) relay operated, transfers, the circuit over lead 1 from the winding of the (STA) relay, to battery through the winding of the

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(SA) relay and the break contact of the (SB) relay. When a call is now received, the (SA) relay operates in turn operating the (STB) relay. This circuit is traced from battery through the winding of the (STB) relay, make contact of the (SA) relay, 600 ohm resistance (B), to ground on the armature of the (CB) relay. The (STB) relay operated, operates relay in the district thus starting a selector in the "B" sub-group hunting for the calling line and closes a locking circuit through the 1000 ohm winding and make contact of the (CA) relay. This is to prevent the release of the (CA) relay should a selector become available in the (A) sub-group while a call is going through the (B) sub-group. If all selectors in sub-group (B) are busy, the operation is similar except that the (CB), (SB), and (ST-A) relays now operate. The (ST-A) relay operated, starts a selector in the (A) sub-group hunting, as explained before.

16. ALL SELECTORS IN BOTH SUB-GROUPS BUSY -

If all selectors in both sub-groups are busy, both the (CA) and (CB) relays are operated. Should a call be received in either sub-group under these conditions, the corresponding (SA) or (SB) relay operates, but neither the (STB) nor (STA) relay operates, as the circuits to ground on the armature of the (CA) and (CB) relays are open. When a call is received in the (A) or (B) sub-group while all selectors are busy, the special message register (MR) in the starting circuit operates through the make contact of the (SA) relay to ground on the armature of the (CB) relay, if the call is in sub-group (A), or through the make contact of the (SB) relay to ground on the armature of the (CA) relay, if the call is in sub-group (B). The message register thus indicates the number of calls which were originated while all the line finder selectors were busy.

17. TESTING LINE FINDER SELECTOR

This circuit, which is shown associated with the starting circuit, enables the testing of any particular line finder selector at any time. The test line used with the test box circuit for making the test is the first or bottom line of the bottom bank in both (A) and (B) sub-groups, the first line terminal in both sub-groups being connected together. When the 184 plug (shown on the line finder circuit) is inserted in the test jack of the line finder under test, the (ST) and (ST-1) leads are connected together and the circuit that supplied battery to the (ST) lead is transferred to lead (Z). When

the plug of the test box cord is inserted in the test jack, the (A) relay operates from ground on the sleeve of the test box cord. The (A) relay operated opens the circuit over lead (TR) and operates the (B) relay. The (B) relay is slow in operating to prevent a call which has just reached the (STA) or (STB) relay from being interrupted. The (B) relay operated, (a) locks to battery on its make contact (b) operates the (C) and (C-1) relays and (c) closes the ring side of the loop through the test box, which operates the (L) relay associated with the test line. The (C) relay operated, (a) transfers the circuit for operating the (STA) relay from the (G) distributor selector bank, (b) opens the normal (ST) lead, (c) connects ground to lead (z), (d) opens the operating circuit for the (ST-B) relay, which would otherwise operate and lock on a call within the last 10 lines in the group. The (CI) relay operated (a) closes a circuit over the (TR) lead from battery on the armature of the (STP-G) magnet, (b) connects the (K) lead of sub-group (A) with the (K) lead of sub-groups (B), thus connecting the (K) commutator segments of all the selectors of both sub-groups together, (c) connects the (Y) lead of sub-group (A) with the (Y) lead of sub-group (B), so that the (GA) relay will be operated by a selector in either sub-group. When the (L) relay in the test line operates, the trip circuit functions and connects ground through a relay in trip circuit, over lead (TR) make contact of the (CI) relay, break contact of the (STA) and (STB) relay to battery on the contact of the (STP-G) magnet, operating the relay in the trip circuit. When the relay in the trip circuit operates, it locks over lead 1, make contact of the (C) relay, break contacts of the (CA) and (SB) relays to battery through the winding of the (STA) relay in parallel with the 18-BH resistance, operating the (STA) relay. The (STA) relay operated, operates the (STP-G) magnet which remains operated until the (STA) relay releases, (b) short circuits the 500 ohm winding of the (CA) relay (c) connects ground to lead (K), (d) operates the (D) relay and (e) closes a circuit from ground through the break contact of the (GA) relay, make contact of the (C) relay over lead (Z) to battery through a relay in the district thus causing the line finder to start hunting for the calling line. The (D) relay operated, locks to ground on the armature of the (A) relay. When the (STA) relay releases, the (E) relay operates from ground on the left armature of the (STA) relay, make contact of the (D) relay, to battery through the break contact and winding of the (E) relay. The (E) relay operated, (a) locks to ground on the armature of the (A) relay, (b) releases the (C) and (C-1) relays, thereby restoring the starting circuit to normal, (c) closes the circuit from battery on the armature of the (STP-G) magnet, which was opened by the operation of the (A) relay and later closed by the operation of the (C-1) relay, through to the (TR) lead. When the plug of the test box cord is removed from the test jack, the (A) relay is released, releasing the (B), (D), and (E) relays, thereby restoring the test circuit to normal.

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18. LINE FINDER DISTRIBUTOR

The distributing selectors A and B are used for distributing calls uniformly to the line finder selectors in sub-groups A and B respectively.

19. LESS THAN 40 SELECTORS FOR 300 LINES

When the number of line finder selectors for a group does not exceed 40 selectors for each 300 lines, the starting circuit shall be equipped with two 200-R distributor selectors. Figure 1 shows these selectors wired and equipped for 16 line finder selectors for each sub-group. When the operation of the (ST-A) relay in the starting circuit connects ground on the start (ST) lead, the (LF) relay that operates depends upon the terminal on which the (A-1) bridging brush is resting. Assume the (A-1) brush is resting on terminal 1 in the regular start circuit of sub-group A. In this case if the first selector is not busy the associated (LF) relay operates and starts a Line Finder hunting for the calling line. If the first selector is busy, the associated (MB) relay will be operated and the circuit through the (LF) relay will be opened. In this case the (LF) relay associated with the next idle selector will operate. Assuming this to be the tenth selector, a circuit is then closed from ground on the (ST-A) relay through the break contacts of the (GA), and (C) relays, the (A-1) bridging brush and terminal 1 of the (A-1) arc of the distributor selector the ST lead make contact of the first (MB) relay, the series make contact of the succeeding operated (MB) relays, break contact of the tenth (MB) relay, to battery through the inner winding of the (LF) relay which operates. The operation of the (GA) relay, operates the (STP-A) magnet from ground on the armature of the (ST-A) relay, through terminal 1 and (A-3) brush, to battery through the winding of the magnet, so that when the (GA) relay releases on the completion of a call, the (STP-A) magnet releases, in turn stepping the selector brushes one step and giving the next selector the preference. When the brushes of the distributor selector advance from the terminals of the last line finder selector terminal 16, the selector is advanced over the spare terminals to the first terminal from ground on the strapped spare terminals through the (A-2) brush. While the selector is advancing over the spare terminals, a call at this time will be routed to the first selector through the (A-1) brush and strapped spare terminals by the strap from terminal 22 to terminal 1 on the (A-1) arc.

20. MORE THAN 40 SELECTORS FOR 300 LINES

When the number of line finder selectors for a group exceeds 40 selectors for each 300 lines, the starting circuit shall be equipped with two 200-P distributor selectors. Figure 2 shows these selectors wired and equipped for 26 line finder selectors for each sub-group. It will be noted that the ST leads from the first 15 line finder selectors of each sub-group are connected in their respective order to the first 15 terminals of the (A-1) and (B-1) arcs and the ST leads of the last 11 line finder selectors of each sub-group are connected in their respective order to the first 11 terminals of the (A-4) and (B-4) arcs. It will also be noted that the brushes of the first three arcs of each selector are in the opposite position from the brushes of the last three arcs, so that only three brushes of a selector will be making contact with terminals at the same time, the other three brushes being open at that time. On a regular call, in sub-group A, the circuit functions, as described for Figure 1, until the first three brushes of the A distributor selector advance from terminals 22. At this time the first three brushes are open and the last three brushes are now resting on the first terminal of the (A-4), (A-5) and (A-6) arcs. The next call in this sub-group will then start 16 selector, if idle, hunting for the calling line. Assume the last three brushes are resting on terminal 11 of the associated arcs and the 26 line finder selector is idle. The operation of the (ST-A) relay in the starting circuit closes a circuit from ground on its armature, break contacts of the (GA) and (G) relays, (A-4) brush and terminal 11, over the ST lead, through the break contact of the (MB) relay of the last or 26 line finder selector in the sub-group, to the associated (LF) relay. The operation of the (GA) relay operates the (STP-A) magnet through the (A-6) brush and terminal 11. The release of the (ST-A) relay releases the (STP-A) magnet, advancing the brushes to the next or terminal 12. Ground on spare terminals 12 to 22 through the (A-5) brush advances the brushes of the selector until the first three brushes are resting on the first terminal of the (A-1), (A-2), and (A-3) arcs. While the selector is advancing over the spare terminals a call at this time will be routed to the first selector through the (A-4) brush and strapped spare terminals by the strap to terminal 1 of the (A-1) arc. The number of line finder selectors for a sub-group may thus be arranged by changing the necessary strapping on the selector arcs. The operation for the emergency selector for sub-group "A", and the regular and emergency selectors for sub-group "B" are similar.

LINE FINDER

21. INITIAL OPERATION

When the receiver at the calling station is removed from the switchhook, various relays in the line circuit operate and connect battery to the H terminal of the line at the line finder multiple bank. When ground is connected to the ST lead, the (LF) relay operates and (a) locks through its windings in series to ground on the make contact of the (H) relay, (b) closes a circuit over lead Y operating the (GA) relay in the starting circuit, (c) operates the UP magnet from ground on an "N" commutator brush and segment, causing the line finder selector to travel upward and hunt for terminals of the calling line, to which battery is connected, as hereinafter described, (d) closes a circuit from the same ground on the "N" commutator brush, operating the (CI) relay.

22. FINDING A SENDER

As the line finder selector starts upward, hunting for the calling line, a circuit is closed through the M commutator, slightly after the brushes of the selector move off-normal. Ground on the M commutator brush and segment, operates the line finder (E) relay. The (E) relay operated, (a) operates the (MB) relay, (b) closes a circuit, operating the (D) relay, (c) opens the operating circuit of the (CI) relay, thus permitting the relay to release if the test brush of the sender selector is making contact with the test terminal of an idle sender. If the test brush of the sender selector is making contact with the test terminal of the busy sender, the (CI) relay locks through its outer winding, lower contacts of cam S, to ground on the test brush of the sender selector. With the (CI) relay held operated, the operation of the line finder (E) relay also closes a circuit operating the (F) relay in the line finder circuit and the district selector (STP) magnet. This circuit is traced from battery through the 1,000 ohm winding of the (F) relay and through the windings and break contact of the STP magnet, make contacts of the (CI) and (E) relays to ground on cam H, thereby stepping the sender selector brushes one step on its back stroke. If the next sender circuit is idle the (CI) relay releases, in turn stopping the selector, but if the next terminal is busy, the (CI) relay remains operated and the sender selector continues to step until an idle sender is found. When the (CI) relay releases, the test terminal of the selected sender is immediately made busy to all hunting sender selectors by ground connected to the test brush from cam H through the make contact of the (E) relay and the break contact of the (CI) relay. This busy ground is connected until the switch advances from position 1-1/4. The operation of the (F) relay

opens the tip and ring leads between the line finder commutator and the district circuit and prevents the district (L) relay from operating and advancing the district switch from normal, should the line finder selector connect to the terminals of the calling line before the sender selector finds an idle sender.

MAKING DISTRICT BUSY

23. THE (MB) RELAY OPERATED

(a) Locks to ground on lead X so that it will not release should the selector return to normal while another call is going through, (b) closes a circuit to battery through the 800 ohm winding of the (F) relay, which operates if it was not previously operated, (c) connects ground on its armature to the series circuit through the (MB) relays of the other selectors in the same group, thus permitting the operation, over lead (CH) of the (CA) or (CB) relays in the starting circuit, when all line finder selectors in the group are off-normal, (d) opens the circuit over lead Y, to prevent the (GA) relay from reoperating, (e) transfers the ST lead to the next line finder, which, if busy, transfers the call over the ST lead in the same manner until an idle line finder is found.

24. RELEASING THE TRIP AND START CIRCUITS

As the line finder selector continues upward, at the end of the tripping zone, the K brush makes contact with the K commutator, thus connecting ground to the K lead which short-circuits and releases various relays in the trip and start circuits. The trip and start circuits are thus released and the circuit over the X lead is opened but the (MB) relay will not release as it is held operated through its operating winding.

25. FINDING CALLING LINE

When the selector brushes make contact with the terminals associated with the calling line, the (H) relay operates from battery in the trip circuit, over lead H, to the H multiple terminal and brush of the H commutator brush and segment, outer contacts of cam W, winding of the (H) relay to ground on the break contact and armature of the (DS) relay. With the (H) relay operated, a 50 ohm non-inductive shunt is connected to its winding, to ground on its armature for the purpose of increasing the current through the 500 ohm winding of the (O) relay in the trip circuit, thus speeding its operation. This is necessary on account of the very short time period during which the H brush makes contact with the H terminal before the circuit over the H lead is opened by the over-throw of the selector. The (H) relay operated, opens the circuit which holds the (LF) relay operated, but (LF) relay does not release

immediately on account of a circuit being closed from ground on the C commutator brush and segment, to battery through both windings of the (LF) relay in series. The (LF) relay is thus held operated until the brushes are centered on the terminals of the calling line. When the circuit through the C commutator segment is opened, the (LF) relay releases and (a) opens the circuit through the UP magnet, which stops the selector brushes on the terminals of the calling line, (b) opens the circuit through the 800 ohm winding of the (F) relay so that when the circuit through its 1,000 ohm winding is opened, by the release of the (CI) relay when the district sender selector seizes an idle sender, the (F) relay releases, (c) closes a circuit operating the (SL) relay. This circuit is traced from ground on the M commutator break contact of the (LF) relay, make contact of the (E) relay, winding of the (SL) relay, cam T, make contact of the (D) relay, to battery on the break contact of the (DS) relay.

26. THE ADJUSTMENT OF THE "C" COMMUTATOR BRUSH

The adjustment of the "C" commutator brush, with the relation to the tripped "H" multiple brush, is such that it does not break contact with the "C" commutator segment, until slightly after the holding circuit through both windings of the (LF) relay is opened by the operation of the (H) relay when the H brush makes contact with the H terminals to which battery is connected. The UP magnet, therefore remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the line terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time, the holding circuit through both windings of the (LF) relay is opened at the "C" commutator, releasing the relay. The (LF) relay released, releases the UP magnet. The selector then drops into place, thus centering the brushes on the line terminals.

27. ADVANCING SWITCH TO POSITION 2

The (SL) relay operated, closes a circuit which operates the (L) and (CH) relays. This circuit is traced from ground on the N commutator brush and segment, through the break contact of the (F) relay, make contact of the (SL) relay, cam O, to battery through the both windings of the (CH) relay. This same ground is then connected through cams O and R to battery through the 800 ohm winding of the district (L) relay. The (CH) relay operated, closes a circuit from ground on cam I, break contact of the (CS) relay, make contact of the (CH) relay to battery through the selector time alarm circuit (not shown) which performs no useful function at this time. The (L) relay operated, closes a circuit advancing the district switch to position 2. This circuit is traced from battery through the R magnet, cam B, make contact of

the (L) relay, to ground through cam M. As the switch advances from position 1, the circuits through the (L) and (CH) relays are opened, releasing the relays and disconnecting the selector time alarm circuit. In position 1 1/2 to 2, the associated sender is held busy by ground through cams I and C.

28. COMPLETING FUNDAMENTAL CIRCUIT

With the switch in position 2, the tip and ring leads are closed from the calling line to the tip and ring leads of the associated sender circuit, thus permitting the dialing tone to be transmitted back over the dialing circuit from the associated sender, as an indication that the apparatus is ready to receive the call by the operation of the station dial. The tip side of the dialing circuit is closed from the tip of the line, through the break contact of the (F) relay, cam P, to the tip brush of the sender selector. The ring side of the dialing circuit is closed from the ring lead of the line, through the break contact of the (F) relay, cam Q to the R brush of the sender selector. In position 2, the (CI) relay operates through its outer winding to ground on cam S, and remains operated until the switch advances from position 10. The (CI) relay operated (a) connects ground through the inner contacts of cam S, to the test brush of the sender selector, thus making the associated sender test busy after the switch advances to position 2, (b) closes the tip side of the fundamental circuit through to the sender, and (c) operates the (CI-1) relay. The (CI-1) relay operated closes the sender control SC lead through cam V, cam U, to battery through the outer winding of the (D) relay. After the sender functions, the fundamental circuit is established for the operation of the district (L) relay and the stepping relay in the sender. This circuit is traced from ground in the sender circuit, through the FT brush, make contact of the (CI) relay, cam L, to battery through the 1200 ohm winding of the (L) relay, which operates. The (L) relay operated, locks through its 1200 ohm winding and make contact, cam L, to the same ground over the FT lead and advances the switch to position 3 from ground on cam M. The 500 ohm winding of the (CH) relay is also connected through cam U, in parallel with the winding of the (D) relay. Should the (CH) relay operate at this time due to a high resistance ground in the sender circuit, no useful function will be performed.

29. DISTRICT BRUSH SELECTION

With the switch in position 3, the Up magnet is operated for brush selection over a circuit traced from battery through the winding of the magnet, cam C, make contact of the (L) relay, to ground through cam M. As the selector moves upward in position 3, carrying the commutator brushes over the commutator segments, the A segment and brush intermittently connect ground to the tip side of the fundamental circuit through

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cams K and L, holding the (L) relay operated, but successively short-circuiting the stepping relay in the associated sender circuit, thus releasing and permitting its reoperation until the proper brush has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay. The (L) relay released, opens the circuit through the UP magnet, thereby stopping the upward movement of the selector, and advances the switch to position 4. When two digit senders are used with this circuit, the advance of the sender replaces the high resistance on the SC lead a 500 ohm ground, thus insuring the operation of the (CH) relay. In position 4, the trip magnet (TM) is operated from ground through cam S, and the (L) relay is operated and locked to ground on the fundamental circuit previously described, advancing the switch to position 5.

30. DISTRICT GROUP SELECTION

With the switch in position 5, the UP magnet is reoperated and the trip magnet being operated, causes the previously selected set of brushes to trip when the selector starts upward. As the selector moves upward for group selection, carrying the brushes over the commutator segments, the B segment and brush intermittently connects ground to the tip side of the fundamental circuit through cam L, holding the district L relay operated, but successively short-circuiting the stepping relay in the associated sender circuit, thus releasing and permitting its operation until the proper group has been selected. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the L relay which in turn opens the circuit through the UP magnet and advances the switch to position 6. When three digit senders are used with this circuit, the advance of the sender replaces the high resistance ground on the SC lead with a 500 ohm ground, thus insuring the operation of the (CH) relay. In position 5 to 6 1/4, a circuit is closed from battery through the (B) brush and terminal of the line test selector, winding of the (PT) selector, brush and terminal of the (S) arc, cam H to ground, energizing the (PT) selector magnet. When the switch advances from position 6 1/4, the energizing circuit is opened, releasing the (PT) selector which steps its brushes one terminal on its back stroke. The line test selector remains in position 2 until the sequence switch is advanced to position 9 3/4. With the switch in position 6, a circuit is closed from ground on the line finder N commutator, brush and segment, through the break contact of the (F) relay, make contact of the (EL) relay, inner contacts of cam O, cam R, to battery through the 800 ohm winding of the (L) relay, operating the relay. The (L) relay operated, advances the switch to position 7.

31. TRUNK HUNTING WITH TRUNK IDLE

Should the first trunk in the group in which the selector is hunting be idle, the (L) relay releases as the switch leaves position 6 1/4. When the switch enters position 6 1/2 and 7 3/4 inclusive, ground is connected to the sleeve of the selected trunk through cam M, break contact of the (L) relay, cam E, as a busy condition until the switch advances to position 7 3/4.

32. TRUNK HUNTING WITH TRUNK BUSY

Should the first trunk in the group in which the selector is hunting be busy, the (L) relay is held operated in a circuit from battery through its inner winding and make contact, cam E to ground on the sleeve terminal of the busy trunk. With the switch in position 7, the UP magnet is re-operated from ground, on cam M under control of the (L) relay and the selector travels upward until an idle trunk is found. When the idle trunk is found, the locking circuit through the inner winding of the (L) relay is opened but the relay does not release immediately, due to a circuit being closed from battery through its outer winding, cam R to ground through the C commutator brush and segment. When the brushes are centered on the trunk terminal the circuit through the C commutator segment is opened and the (L) relay releases and opens the circuit through the UP magnet, which stops the selector brushes on the terminals of the selected trunk. The (L) relay released, also advances the switch to position 8.

33. "C" COMMUTATOR

The adjustment of the "C" commutator brush, with relation to the tripped sleeve multiple brush, is such that it does not break contact with the C commutator, until slightly after the holding circuit through the inner winding of the (L) relay is opened, by the sleeve brush leaving the busy terminal and making contact with the sleeve terminal of the idle trunk. The UP magnet, therefore, remains operated and the selector continues to travel upward until the brushes are carried slightly above the center of the trunk terminals, allowing the locking pawl to enter the notch on the rack attached to the brush support rod. At this time, the holding circuit through the outer winding of the (L) relay is opened at the "C" commutator, releasing the (L) relay which in turn releases the UP magnet. The selector then drops into place, thus centering the brushes on the trunk terminal. During trunk hunting, in position 7 only, the commutator feed ground is supplied from ground on cam M under control of the (L) relay. This is to prevent the reoperation of the (L) relay by the closing of a circuit between the C commutator brush and segment on the overthrow of the selector or as it drops into place.

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34. SELECTION BEYOND

As the switch advances to position $7 \frac{3}{4}$, ground through cam E is connected to the sleeve of the selected trunk as a busy condition. With the switch in position 8, a circuit is closed from ground on the armature and make contact of the (CH) relay, through cam O, cam R to battery through the outer winding of the (L) relay which operated, advancing the switch to position 9. In position 9, the tip and ring sides of the outgoing fundamental circuit are closed through the tip and ring terminals of the selected trunk for selection beyond, through the FT and FR brushes of the sender selector, and cams F and G respectively. After selection beyond has been completed, ground in the sender is removed from the SC lead, releasing the (CH) relay, in turn releasing the (L) relay. The (L) relay released, advances the switch to position 10. As the switch leaves position $9 \frac{1}{2}$, the dialing circuit is opened at cams P and Q and, in position $9 \frac{3}{4}$, the tip and ring leads from the line finder are closed through cams P and Q respectively to the (PT) selector switch.

35. FIRST TEST OF CALLING LINE

As the district switch enters position $9 \frac{3}{4}$ to $10 \frac{1}{2}$, the (PT) magnet operates in a circuit through the S brush and 2 terminal to ground on cam H. The (PT) magnet operated, steps the brush assembly to terminal 3. With the line test switch on terminals 3, 4, 5, and 6, 48 volt battery is connected to the tip side of the subscriber's line, through terminal 3 and (T) brush of the selector and cam P. The charge in the station condenser is thus neutralized so that it will not interfere with the proper functioning of the (T) relay as the line is tested, when the line test switch enters a test position. A circuit is also closed from battery through one winding of the repeating coil, winding of the (DC) relay, (R-3) brush and terminals 3 of the test switch, to ground through the non-inductive winding of the (RC) relay, operating the (DC) relay. The operation of the (DC) relay closes a holding circuit for the (D) relay. With the line test switch on terminal 3, a circuit is also closed from battery through its B2 brush and 3 terminal, to ground through the inner winding of the (RT) relay which operates.

36. ROUTINE TEST

The (RT) relay operated, (a) closes a circuit from ground on cam W through the (C) brush and 3 terminal of the line switch, make contact and 3400 ohm winding of the (RT) relay, to battery through the winding of the (T) relay which operates and (b) connects ground on its armature to the selector time alarm circuit. The function of the

(RT) relay is to make a routine test of the (T) relay on each call before it is connected to the line in connection with making two-party tests. If the (T) relay operates satisfactorily in series with the 3400 ohm winding of the (RT) relay, it does so on less current than it would receive under the worst line circuit conditions, thus assuring its operation under the worst circuit condition. If the (T) relay does not operate in series with the 3400 ohm winding of the (RT) relay, the (PT) selector remains on terminal 3, causing the selector time alarm circuit to function. When the (T) relay operates on a routine test, a circuit is closed from ground on its armature, make contact of the (RT) relay, to battery through the inner winding of the (I) relay which operates. The (I) relay operated, closes a circuit from ground on its armature, terminal 3 and (S) brush of the party line test switch to battery through the winding and break contact of the (PT) magnet, operating the selector which steps the brushes to terminal 4. With the line test switch on terminal 4, the operating circuit for the (T) relay is opened, at the C brush, releasing the (T) relay. The (T) relay released, opens the circuit through the (I) relay which releases. The (I) relay released, steps the selector to terminal 5 in a circuit traced from ground on the armature and break contact of the (I) relay, terminal 4 and (S) brush of the selector, to battery through the winding of the (PT) magnet. With the line test switch on terminal 5, a circuit is closed from battery through the winding of the (PT) magnet, (S) brush and terminal 5 to ground through the make contact of the 149-A interrupter, operating the 200-S selector. When the contacts of the interrupter break, the energizing circuit of the selector magnet is opened, releasing the magnet, which steps the brushes to terminal 6. The 200-S selector continues to operate under control of the 149-A interrupter, advancing the line test switch to position 8. Ground through the S brush and terminal S advances the switch to position 9.

37. TESTING SUB-STATION

At terminal 7 of the line test switch the subscriber's line is tested to determine which party on the line has originated the call, in order that the call may be registered correctly. If the call originates at the station whose ringer is connected to ground through a condenser, the (T) relay does not operate. If, however, the call originates at the station with the grounded ringer, the (T) relay operates in turn operating the (RC) relay. The (T) relay operates in a circuit from ground through the sub-station ringing, over the tip side of the line, through the cam P, (T) brush and terminal 7 of the line test selector, to battery through the winding of the (T) relay. The operation of the (T) relay closes a circuit from ground on its armature, break contact of the (RT) relay make contact of the (CI-1) relay to battery through the outer winding of the (RC) relay which operates. The (RC) relay operated, transfers the circuit to the message register as explained hereinafter.

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38. TALKING SELECTION

With the switch in position 10, the sender circuit functions and connects ground to the FT lead, causing the (L) relay to operate and lock through its inner winding over the tip of the fundamental circuit previously described. The (L) relay operated, advances the switch for talking selection. This circuit is traced from battery through the R magnet, cam B, make contact of the (L) relay, to ground through terminal 9 and (C) brush of the line test selector. As the switch advances, ground is intermittently connected to the tip side of the fundamental circuit through cam E, holding the (L) relay operated, but successively short-circuiting and permitting the reoperation of the stepping relay in the sender circuit. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened, releasing the (L) relay. The (L) relay released, opens the circuit through the R magnet, stopping the switch in position 11, 12 and 13, depending upon the class of call. When the line test switch leaves terminal 7, the (T) relay releases, and 48 volts battery is disconnected from the tip side of the line. With the line test switch on terminal 9 and the district sequence switch in position 10, a circuit is closed energizing the 200-S selector. This circuit is from ground cam H, terminal 9 and (S) brush of the switch, winding of the (PT) magnet, to battery through terminal 9 and (B) brush of the selector. As the district switch advances from position 10 1/2, the operating circuit of the (PT) magnet is opened at cam H, releasing the magnet which steps its brushes to terminal 10. With the test switch on terminal 9, the holding circuit of the (DC) relay is transferred from the non-inductive winding of the (RC) relay and closed metallic over the sub-station loop. This circuit is traced from battery through one winding of the repeating coil, winding of the (DC) relay, (R) brush and terminal 10 of the line test switch, cam Q, break contact of the (F) relay, terminal and brush of the line finder, through the station loop, back through the terminal and brush of the selector, break contact of the (F) relay, lower contacts of cam P, (T) brush and terminal 10 of the test switch to ground through the outer winding of the repeating coil.

39. DISCHARGING THE SENDER

With the (DC) relay operated, a locking circuit is closed for the (D) relay after the switch advances from position 9. The (D) relay (178-AK) is made slow in releasing so that the connection will not be lost if the switchhook at the called station is momentarily depressed. As the switch leaves position 10, the holding circuit of the (CI) relay is transferred from ground on cam S to ground on cam E, under the control of the (L) relay. This circuit is traced from battery through the outer winding of the (CI) relay, inner contacts of cam U, make contact of the (CI-1) relay, cam V, make contact of the (L) relay to ground

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through cam E. The release of the (L) relay opens the holding circuit through the (CI) relay, disconnecting the sender from the district circuit.

40. CALLER PARTY ANSWERS

When the receiver at the called station is removed from the switchhook, with the switch on position 11 or 12, reversed battery and ground from the incoming circuit operates the (CS) relay. The (CS) relay operated, closes a circuit from ground on cam I, through cam N, winding of the (I) relay to battery through the #3 contact of the 149-J interrupter. When the interrupter contact closes, the (I) relay operates and locks to the same ground through its make contact. When the #4 contact of the interrupter closes, the operation of the (I) relay closes a circuit from ground on the interrupter contact to battery through the windings of the (CH) relay, operating the relay. The (CH) relay operated, locks through cam O, to ground on its make contact and closes a circuit to hold the (SL) relay operated. The 149-J interrupter is so connected in the circuit that the operation of the (CH) relay is delayed for at least two seconds after the (CS) relay operates. This delay is to prevent the false operation of the (CH) relay should the (CS) relay operate momentarily before the called party answers due to any line disturbances.

41. OPERATOR ANSWERS

The switch advances to position 13, as described above, and when the operator inserts the plug of an answering cord in the answering jack of the trunk, the (CS) relay operates on reverse battery and ground, over the trunk. The (CS) relay operated, closes a circuit from ground on cam I, through cam R, to battery through the outer winding of the (L) relay, which operates and advances the switch to position 14. With the switch in position 14, the repeating coil and battery are disconnected and the T and R leads are connected directly to the T and R brushes of the selector through cams P and Q, respectively. As the switch enters position 13 1/2, the (L) relay locks in a circuit from ground over lead S of the selected trunk, and in position 14, the locking circuit through the inner winding of the (D) relay is transferred from the contacts of the (DC) relay to the contacts of cam J. In position 14, a checking tone circuit is closed over the sleeve of the operator's trunk, cam E, make contact of the (L) relay, cams V and Y, 2 mf condenser, cam X, the S brush and terminal at the line finder bank, to ground through the winding of the (CO) relay for number checking.

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42. DISCONNECTION - REGULAR CALL

When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases, in turn releasing the (D) relay. The (D) relay released, closes a circuit through the R magnet, advancing the switch to position 16. As the switch passes through positions 13 to 13 1/2 and 14 3/4 to 15 1/4, a circuit is closed from ground on cam H, operating and releasing the (PT) magnet, thus stepping the line test switch to terminal 12. The 149-A interrupter steps the switch to position 16.

43. SECOND TEST OF CALLING LINE

As the line test switch passes over terminals 12 and 13 with the district switch in position 16, battery is connected through the (T) brush and cam P to the tip side of the line to discharge the substation condenser. On terminals 14 15 and 16 of the line test switch, a second test is made on the line. During this test, the tip and ring of the line are short-circuited through the make contact of the (CH) relay, in order to test for a foreign ground on either side of the line. With the district switch in position 16, the (I) relay operates in a circuit from battery through its inner winding, to ground on terminal 10 and (C-5) brush of the line test switch, and remains operated until the line test switch advances from position 15. If the (T) relay operates in position 14 to 16 of the test switch, the (I) relay is held operated and the line test switch steps to terminal 16. The holding circuit is traced from ground on the armature of the (T) relay, make contact of the (RT) relay, to battery through the inner winding of the (I) relay. With the (I) relay operated, the test switch is held on this terminal and a circuit is closed, operating the selector time alarm circuit. When the alarm is investigated, the sequence switch must be advanced to position 17, manually, to prevent a false charge to the calling station. If, however, the line is free from ground when the second test is made, the (T) relay does not operate and the (I) relay releases and closes a circuit from ground through its break contact, terminal 16 and (S) brush of the test switch, to battery through the winding and break contact of the (PT) magnet, stepping the brushes to terminal 17. The selector then steps to position 20 under control of the 149-A interrupter in order to allow sufficient time for the operation of the message register in the associated line circuit.

44. MESSAGE REGISTERED

As explained under first test of calling line, the (RC) relay operates and locks on the first line test when the call originates at the station with the grounded ringer, but does not operate on line tests when the call originates at the station whose ringer is connected in series with a condenser. The operation or non-operation of the (RC) relay determines which station register shall register the call. If a call originates at the station whose ringer is connected to ground in series with a condenser, the (MR-1) message register in the line circuit operates. The registering circuit is traced from battery on the make contact of the (CH) relay through cam T break contact of the (I) relay, break contact of the (RC) relay, through the 18-AN resistances in multiple over lead H break contact of the (L) relay make contact of the (CO) relay, through winding of the (MR-1) message register to ground.

45. On calls originating at the station whose ringer is permanently connected to ground, the (RC) relay operates and locks and closes a circuit short-circuiting the (E) relay which releases. This circuit is traced from ground on (C) brush and terminals 18 and 19 of the line switch make contact of the (RC) relay to the winding of the (E) relay short-circuiting the inductive winding of the (E) relay. The (E) relay released, (a) opens the circuit through the (SL) relay which releases, (b) opens the operating circuit for the (MB) relay, but the (MB) relay does not release on account of a circuit being closed to ground on cam I. The release of the (SL) relay opens the circuit, releasing the (CO) relay. When the (CO) relay releases, the (MR-2) message register is connected to lead H and the registering circuit for the second-party station is traced from battery on the make contact of the (CH) relay, break contact of the (I) relay, make contact of the (RC) relay, contact of the (G) relay, through the 18-AN resistances in multiple, cam W, brush and commutator of the LF selector, over lead H, break contact of the (L) and (CO) relays, to ground through the winding of the (MR-2) message register.

46. As the operation of register MR-2 is dependent on the release of the (SL) relay, it will be noted that the sleeve of the line at the final frame is left unguarded by the release of the (SL) relay. In the event that the line is again seized by a final selector immediately upon the release of the (SL) relay, the (G) relay operates and opens the register circuit, thus preventing the wrong station being charged with the call. The (G) relay operates in a circuit from ground through cam E, cam L, cam K, through the winding of the (G) relay, over the S lead to battery on the S lead of the final selector which seized this line.

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47. RESTORING LINE FINDER TO NORMAL

As the line test switch steps to terminal 20, a circuit is closed from ground on the (C) brush and terminal 20 of the line test switch, advancing the district switch to position 17. The A cam advances the switch to position 18. As the switch enters position 17, a circuit is closed operating the (DS) relay. The (DS) relay operated, (a) locks through its make contact and 350 ohm winding to the same battery, (b) closes a circuit through the outer winding of the (F) relay, thus insuring the holding of this relay until both the line finder selector and the district selector have returned to normal, (c) operates the line finder DOWN magnet from ground on its armature, which restores the line finder selector to normal. When the line finder selector returns to normal, ground is disconnected from the M commutator segment, releasing the (E), (DS), and (MB) relays.

48. RESTORING DISTRICT TO NORMAL

With the district switch in position 18, a circuit is closed from ground on cam I, break contact of the (D) relay, cam D, terminal 20 and (S) brush of the test switch, to battery through the winding of the (PT) magnet which operates and advances the switch to terminal 21. With the line test switch on terminal 21, the circuit is closed from ground on the (C) brush and terminal 21 of the test switch to battery through the DOWN magnet, restoring the district selector to normal. When the district selector reaches the bottom of the frame, a circuit is closed from ground through the Y commutator brush and segment, (D) brush and terminal 21, (S) brush and terminal to battery through the (PT) magnet, stepping the brushes to terminal 22. With the test switch on terminal 22, a circuit is closed from ground on the terminal 22 and (S) brush to battery through the (PT) magnet, stepping the switch to terminal 1. With the line test switch on terminal 1, ground through the Y commutator brush and segment, (D) brush and terminal 1 of the line test switch, cam B to battery through the R magnet, advances the district switch to position 1. As the switch leaves position 18, the circuit through the DOWN magnet is opened, and after position 18 1/4, the circuit through the outer winding of the (F) relay is opened, releasing the relay.

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49. DELAYED DISCONNECT

Should the calling subscriber fail to replace the receiver on the switchhook after the called subscriber has disconnected, the release of the (CS) relay, due to the incoming trunk functioning, operates the selector time alarm circuit from ground through cam I over the circuit previously described, thereby notifying the switchman of the existing condition.

50. DISCONNECTION - TALKING TO OPERATOR

With the plug of the answering cord in the trunk jack at the incoming end, ground is connected to the sleeve terminal of the trunk to hold the district (L) relay operated. If the plug of the cord is removed from the trunk jack before the receiver at the calling station is replaced on the switchhook, the line relay in the trunk circuit operates, thereby holding the ground on the sleeve terminal of the trunk. When the receiver at the calling station is replaced on the switchhook and the plug of the answering cord is removed from the trunk jack at the incoming end, ground is disconnected from the sleeve of the trunk, releasing the (L) relay, thus advancing the switch to position 15. As the switch advances from position 14 1/4, the locking circuit through the inner winding of the (D) relay is opened at cam J, releasing the relay. The (D) relay released, releases the (SL) relay and then advances the switch to position 16 in a circuit traced from battery through the R magnet, cam D, break contact of the (D) relay, to ground through cam I. With the test switch in position 20, a circuit is closed on the (C) brush and terminal 20, break contact of the (L) relay, cam B to battery through the R magnet advancing the switch to position 17, the A cam advancing to position 18. In position 16, the (CH) relay being normal, battery is not connected over lead H to operate the message register in the line circuit, as the call is not chargeable. From this point on, the line finder and district selectors are stored to normal as described in previous paragraphs.

51. DISCONNECTION BEFORE THE LINE FINDER SELECTOR FINDS LINE

Should the calling subscriber replace the receiver on the switchhook before a hunting selector finds the line, the (L) relay in the line circuit releases, removing battery from the H terminal at the multiple bank. The selector therefore, travels to the top of the bank and the H brush of the selector makes contact with the terminal of the H comb at the top of the multiple bank. The (H) relay operates from ground on the break contact and armature of the (DS) relay, winding of the (H) relay cam W, H brush of the selector to battery. The (H) relay operated, releases the (LF) relay, which in turn releases the (F) relay and opens the circuit through the UP magnet, stopping the selector. The N commutator

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segment is opened with the selector brush resting on the H comb to prevent the district switch from advancing from normal when the (F) relay is released by the release of the (LF) relay. When the (F) relay releases, the (DS) relay operates from ground on the X commutator brush and segment, through its 1,000 ohm winding. The (DS) relay operated, operates the DOWN magnet, restoring the selector to normal.

52. POSITIONS 2 TO 6.

If the receiver is replaced on the switchhook at the calling station while the district switch is in positions 2 to 6, the dialing circuit is opened at the calling station, causing the sender circuit to function and connect a direct ground to the SC lead operating the (CH) relay and causing the (D) relay to release on account of the increased current flow through the outer winding of the relay. The (D) relay is connected differentially, but does not release when its inner winding is connected directly to ground and its outer winding connected to ground in series with a resistance. The (D) relay released, advances the switch to position 6 in a circuit traced from ground through cam I, break contact of the (D) relay, cam D to battery through the R magnet.

53. In position 6 the DOWN magnet operates, restoring the district selector to normal. When the selector reaches the bottom of the bank, a circuit is closed from ground through the Y commutator brush and segment, (D) brush and terminal 1 of the test switch, cam B to battery through the R magnet, advancing the switch to position 7. In position 7, a circuit is closed from battery, break contact of the (DS) relay, break contact of the (D) relay, cam N, through the outer winding of the (DS) relay, to ground on the M commutator, operating the (DS) relay. When the district switch advances from position 6 1/4, the (L) relay releases and closes a circuit advancing the switch to position 8.

54. As the district switch enters position 6, the (PT) selector is operated from battery over the (B) brush and terminal, and when the district switch advances from position 6 1/4, the (PT) magnet releases stepping the test switch to position 2. Ground on the Y commutator through the D and S brushes steps the test switch to position 4. The test selector steps to terminal 5 from ground on the break contact of the (I) relay and steps to terminal 8 under control of the 149-A interrupter. Ground on terminal 8 advances it to terminal 9. Ground on the Y commutator through terminal 9 and 10 advances the district to position 14. As the district switch enters

position 9 3/4 the (PT) magnet operates and as it advances from position 10 1/2, the (PT) magnet releases, stepping the line test switch to terminal 10. When the district switch advances to position 10, a circuit is closed from ground on cam I, break contact of the (D) relay, cam D to battery through the R magnet, advancing the switch to position 16. As district switch passes through position 13, the (PT) magnet operates, and when the district switch advances from 13 1/2, the (PT) magnet releases, stepping the line switch to terminal 11. In position 14 3/4 the (PT) magnet again operates and releases when the district switch advances from position 15 1/4. The release of the (PT) magnet advances the test switch to terminal 12. Ground through the 149-A interrupter is connected through the (PT) magnet, advancing the test switch to terminal 16. On terminal 16, ground on the break contact of the (I) relay advances the test switch to terminal 17. The switch advances to terminal 20, under control of the 149-A interrupter, and closes a circuit from ground through the (C) brush and terminal 20, advancing the district switch to position 17, the A cam advancing it to position 18. Ground on cam I, break contact of the (D) relay, cam D, (S) brush and terminal 20 of the test selector advances the switch to terminal 21. The Y segment advances the switch to terminal 22. On terminal 22 ground through the (S) brush steps the test switch to terminal 1, where a circuit is closed from ground the Y commutator, (D) brush and terminal 1, advancing the district switch to position 1.

55. When the line finder selector returns to normal, ground is disconnected from the M commutator, thus releasing the (E), (DS) and (MB) relays. The (DS) relay released, releases the (F) relay and the (E) relay released, releases the (SL) relay. The (SL) relay released opens the circuit releasing the (CO) relay, thus restoring the circuit to normal.

56. POSITION 7 TO 10

If the receiver at the calling station is replaced on the switchhook while the district switch is in position 7 to 10, the switch advances until selection beyond is completed, when ground is disconnected from the (SC) lead in position 10, and connected to the FT lead, operating the (L) relay. The (L) relay operated, advances the switch to position 11. With the switch in position 11, the (D) relay releases, closing a circuit from ground on cam I, break contact of the (D) relay, cam D, to battery through the R magnet, advancing the switch to position 16. As the switch advances from position 16, the line test switch steps to terminal 21, and in position 16, the (L) relay releases, advancing the switch to position 17, the A cam advancing it to position 18.

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TELL-TALE - LINE FINDER SELECTOR

57. BRUSHES NOT TRIPPED

Should the selector travel to the tell-tale position while hunting, due to the multiple brush not being tripped, the (F) relay remains operated through its outer winding. Ground on the X commutator brush and segment is thereby connected to the lead "To Tell-Tale Circuit", giving a visual signal to the attendant. As the N commutator segment is open at tell-tale, the district is prevented from advancing from normal position. The selector in this case is restored to normal manually by the attendant.

58. WITH BRUSHES TRIPPED

Should the selector travel to the tell-tale position while hunting, with the multiple brush tripped, a circuit is closed from battery in the trip circuit, terminal of the H comb at the top of the multiple bank shown on trip circuit, H multiple brush of the line finder selector, contacts of cam W, winding of the (H) relay, to ground on the armature of the (DS) relay, operating the (H) relay. The (H) relay operated, releases the (LF) relay which in turn releases the (F) relay and UP magnet. The (F) relay releases, opens the circuit through the tell-tale alarm and connects ground through the X commutator brush and segment to battery through the 1000 ohm winding of the (DS) relay, which operates, in turn operating the DOWN magnet, restoring the selector to normal.

59. TELL-TALE DISTRICT SELECTOR

Should the selector travel to the tell-tale position during brush selection, ground on the X commutator and segment is connected through cam B, to battery through the R magnet, advancing the switch to position 8. Under this condition, the resistance of the circuit over the SC lead is too high to allow the (CH) relay to operate and the district remains in position 8 until it is restored to normal manually. If the district goes to tell-tale during group selection, ground on the X commutator advances it to position 8. In position 8, ground on the SC lead holds the (CH) relay operated, which in turn operates the (L) relay. The (L) relay operated, advances the switch to position 9. The (CH) and (L) relays remain operated and the district remains in position 9 until it is restored to normal manually.

60. OVERFLOW

If all the trunks in the group are busy, the district selector, while trunk hunting in position 7, travels to the top of the group and rests on the overflow terminals. As the sleeve terminal at overflow is open, the (L) relay released, in turn advancing the switch to position 8. In position 8, the (L) relay reoperates from ground on the armature of the (CH) relay, advancing the switch to position 9 where ground on the Z commutator advances it to position 10. In position 10, a circuit is closed from ground on the Z commutator brush and segment, through cams K, and L, to battery through the 1200 ohm winding of the (L) relay, operating the (L) relay. The (L) relay operated, locks through its 1200 ohm winding and make contact to the same ground, through cam L, advancing the switch to position 14 from ground on cam M. As the switch advances from position 13, the (L) relay releases, and in position 14 advances the switch to position 15. The release of the (L) relay also releases the (CI) and (CI-1) relays, disconnecting the sender from the district circuit. With the switch in position 15, a circuit is closed from the "Miscellaneous Tone Circuit" over lead C, 2 mf condenser, cam G, winding of the repeating coil, 2 mf condenser, cams Y, V and J, make contact of the (D) relay, to ground on cam I. A tone is therefore induced in the other winding of the repeating coil, thus causing the "All trunks Busy" tone to be sent back to the calling subscriber. When the receiver at the calling station is replaced on the switchhook, the (DC) relay releases, opening the locking circuit through the (D) relay, which releases. From this point on, the switch is advanced to position 1 as described in paragraph 34.

61. "O" COMMUTATOR

The function of the "O" commutator segment is to maintain an idle condition on the multiple overflow terminals, so that more than one selector may stop on overflow at one time; otherwise, the first selector reaching overflow would make the sleeve multiple terminals busy, thus causing succeeding selectors to continue upward into the next group of trunks. The "O" commutator segment is open at overflow, but the S bar is continuous. Both the "O" and "S" commutator brushes are permanently strapped together and wired to the multiple sleeve brush. When the selector is at overflow, the "O" commutator brush is resting on an open (dead) segment, and as the busy ground is fed through the "O" commutator bar only, this arrangement maintains a non-busy condition of the sleeve terminals. When necessary to combine two or more groups of trunks, the multiple sleeve overflow terminals between the combined groups are made permanently busy by being connected to ground. As the "S" commutator bar is closed at overflow, the (L) relay is held operated at this time, and the selector therefore hunts past the "made busy" terminals into the next group.

62. LINE FINDER TIME ALARM

If a line finder does not find the subscriber's line within 35 seconds after the receiver at the calling station is removed from the switchhook, an alarm is given in the following manner: When the receiver at the calling station is removed from the switchhook, various relays in the line and trip circuits operate and connect battery to lead B, winding of the B (frame) relay brush and terminal 1 of the START arc of the time alarm selector, break contact of the A frame relay, to the interrupter contact. When the interrupter contact closes, the B relay operates. The A (frame) relay does not operate, however, on account of its winding being short circuited by ground on the interrupter. When the interrupter contact opens, the short circuit is removed from the winding of the A relay, which now operates in series with the winding and made contact of the B relay, to ground on the armature of its B relay, thus holding both relays operated. The next operation of the interrupter operates the STP magnet, over a circuit from ground on the make contact of the interrupter, make contact of the A relay, terminal 1 and brush of the STP magnet. When the interrupter contact opens the STP magnet releases and steps its brushes one step on its back stroke. The selector brushes advance one step for each make and break of the interrupter contact, which is of an interval of 7 seconds, until the fifth terminal of the selector is reached when the circuit through the interrupter is opened. When the fifth terminal of the selector is reached, the BA-1 lamp in the trip circuit lights from battery on the armature of the A (frame) relay, terminal 5 and brush of the LAMP arc of the selector, lead A, through the make contact of the BA relay, BA-1 lamp, lead C, to ground through the winding of the B (aisle) relay in the time alarm circuit, which operates. The B relay operated, operates the A (aisle) relay. The A relay operates, lights the aisle pilot and main or monitoring board lamps through their respective auxiliary alarm circuits. When the source of trouble is removed and the BA relay, in the trip circuit has released, the circuits over leads A and B are opened, in turn releasing both the frame and aisle A and B relays, extinguishing the aisle and main or monitoring board lamps and silencing the alarm. The release of the B (frame) relay also closes a circuit from ground on its armature, through terminal 5 and the bridging brush of the RETURN arc of the selector to battery through the break contact and winding of the STP magnet, which operates and steps the selector brushes to terminal 6, in which position it awaits the next closure of lead B.

63. RESTORING TO NORMAL

Should the circuit over lead B be opened before the fifth terminal is reached by the selector, the A and B frame relays release. The B relay released, causes the selector to advance to the next normal position,

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awaiting closure of lead B, as previously described. The operation of the (NL) key steps the selector brushes to the next normal position by way of the STEP bridging brush and 5, 10, 15 or 20 terminal, as the case may be. If the selector has been at normal position 6, 11, or 16, when the BA relay operated, the operation would have been the same as described for position 1.

64. WIRING OF GROUP DISTRIBUTOR BANK

The wiring of the group distributor arc of the regular "G" distributing selector bank, shown on the regular starting circuit, and of the emergency G distributor selector bank, is shown in detail in the circuit associated with the series circuit through the emergency jack and the contacts of the (TR) and (TR-1) relays for the 15 groups of a panel line finder frame. For a complete frame of 300 lines, the wiring of the terminals for both arcs of each (G) distributor selector is shown. As a trip circuit is divided into two units, (A) and (B) calls originating in the first 10 lines of a group of 20 lines are connected through trip unit (A) and a terminal and brush of the (G) arc normally having access to the line finders in sub-group (A). Calls originating in the last 10 lines of a group are connected through trip unit (B) and a corresponding terminal and brush of the other arc normally having access to the line finders in sub-group (B). This arrangement permits the distributing of the 15 trip circuit (A) and (B) units to sub-groups (A) and (B), respectively, in the starting circuit, so as to give each group an equal preference, thus preventing any one group from having a permanent preference over the other groups. This is accomplished by the (G) selector being advanced one step to the next group after each call. The series circuit through the contacts of the (TR) and (TR-1) relays permits the passing of a call through a number of idle groups with the same speed as though the call originated on a line within the group having the preference at that time. Should two or more calls start in two or more groups at the same time, the group nearest the one having the preference at that time will be completed first, because of the series locking arrangement of the (TR) or (TR-1) relay holding the relay of this group locked and releasing the other relays.

65. LOCKING CIRCUIT THROUGH (TR) RELAYS -

The (TR) relay in any group locks from ground through its 600 ohm winding and make contact, jack 10, terminal and brush of the associated arc of the (G) selector, to battery in the starting circuit through jack 15. The (TR-1) relay locks through its 600 ohm winding and make contact, jack 12, corresponding terminal and brush

of the associated (G) arc, to the starting circuit through jack 16. Jacks 10 and 12 of each group circuit are wired to the selector arc terminals and jacks 9 and 11 loop to the next group circuit, so that though the selector may be giving preference to one group, this group being idle, and a call originates in some other group, a circuit is closed back through the intervening jacks and break contacts of the intervening relays of each group until the terminal which the distributor brush is resting on is reached. Assume a call originates in group 15, and is passing through trip unit (A) and the brushes of the (G) distributor selector arc are resting on the first group terminal 1, which is terminal 1. The locking circuit for the (TR) relay will be as follows: Through the 600 ohm winding and make contact of the (TR) relay and jack 10 of group 15, jack 11, break contacts of the (TR-1) and (TR) relays, and jack 10 of group 14 (not shown), through all other groups in the same manner to jack 10 of group 1, terminal 1 and brush of the selector, to jack 15 of the starting circuit. It will be seen that if two calls start at the same time in two different groups causing the (TR) relays in the two groups to operate together, the call originating in the group nearest the one having the preference of the starting circuits will be completed first. For example, if a call started in group 10, trip unit (A), and an other in group 15, trip unit (A), the operation of the (TR) relay in the former group would release the (TR) relay in the latter circuit, but remain locked itself. The magnet of the (G) selector is operated by ground in the start circuit and the brushes advance one step on the release of the selector armature when the start circuit releases after each call.

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